Staff Workshop on Research Needs for Renewable Energy Forecasting

Arthur Rosenfeld Hearing Room
California Energy Commission
January 17, 2017

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Energy Generation Research Office
Energy Research and Development Division

Housekeeping

- Facilities
- Emergency Exit
- Sign-In Sheet
- Online participation

Commitment to Diversity

The Energy Commission adopted a resolution strengthening its commitment to diversity in our funding programs. We continue to encourage disadvantaged and underrepresented businesses and communities to engage in and benefit from our many programs.

To meet this commitment, Energy Commission staff conducts outreach efforts and activities to:

- Engage with disadvantaged and underrepresented groups throughout the state.
- Notify potential new applicants about the Energy Commission's funding opportunities.
- Assist applicants in understanding how to apply for funding from the Energy Commission's programs.
- Survey participants to measure progress in diversity outreach efforts.

We Want to Hear From You!

1 Minute Survey

- The information supplied will be used for public reporting purposes to display anonymous overall attendance of diverse groups.

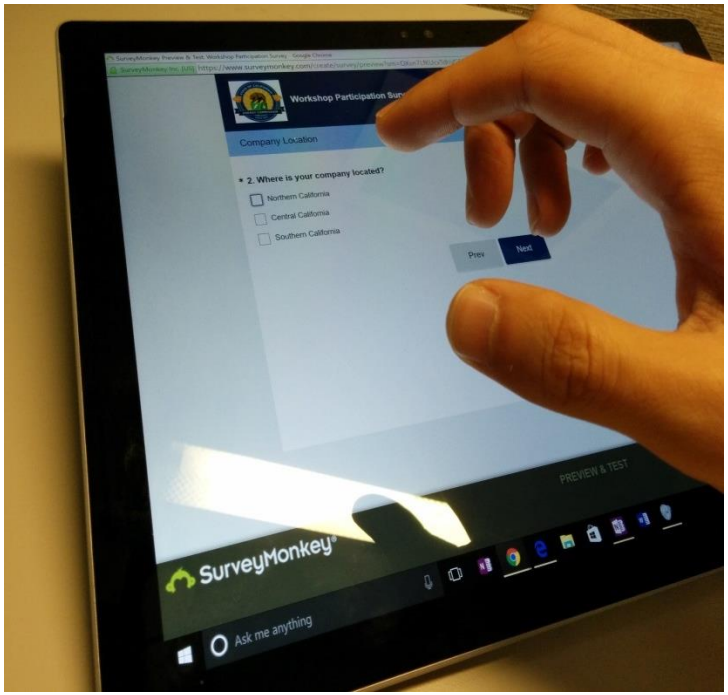
- **iPads are being passed around the room**

- **Online SurveyMonkey for WebEx Participants:**

https://www.surveymonkey.com/r/CEC-01-17-2017

- **We have also hard copies in the room**

Thanks for your time!



Connect With Us

Commission's listserves
www.energy.ca.gov/listservers

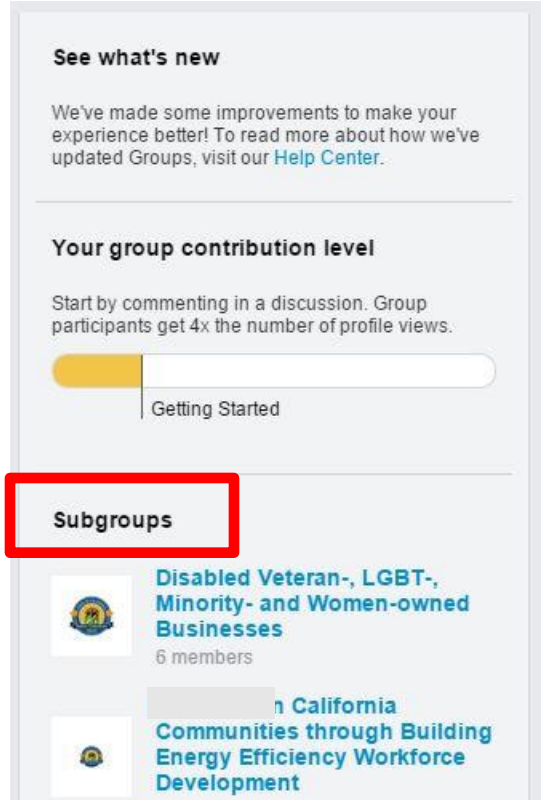
Find Partners via LinkedIn

The Energy Commission has created a user-driven LinkedIn group page to help potential applicants **connect, collaborate** and **partner** on proposals for funding opportunities.

•Participants can join the "California Energy Commission Networking Hub" by:

- Searching for the "California Energy Commission Networking Hub" group; or
- Entering this link into your browser: (bit.ly/CalEnergyNetwork)

•Once there, find and join the desired solicitation subgroup.



Agenda

Session
Welcome, Introduction, and Brief Overview of Solar and Wind Forecasting R&D
Panel 1: Renewable Energy Forecasting Research Opportunities and Solutions to Support Modern Grid Facilitator: Melinda Marquis, NOAA Earth System Research Laboratory
Q&A, Public Comments
Break
Panel 2: Forecasting Gaps, Building a Sensor Network, and Managing Costs Facilitator: William Shaw, Pacific Northwest National Laboratory - DOE
Q&A, Public comments
Recommendations and Closing Remarks

Workshop Goals

- Dialog among developers, utilities, and balancing authorities to ensure that forecasting tools and methods are addressing the operational needs.
- Solicit feedback or suggestions from stakeholders and the public.
- Inform the implementation of forecasting research projects.
- Refine funding initiatives to be included in the Electric Program Investment Charge (EPIC) 2018-2020 Triennial Investment Plan.

About EPIC

- The Electric Program Investment Charge (EPIC) is funded by an electricity ratepayer surcharge established by the California Public Utilities Commission (CPUC) in 2011.
  - Annual program funds total $162 million per year (adjusted for inflation) with 80% administered by the California Energy Commission.
- The purpose of EPIC is to:
  - Benefit the ratepayers of the three largest electric investor-owned utilities, Pacific Gas and Electric Co., San Diego Gas and Electric Co., and Southern California Edison
  - Fund clean energy technology projects that promote greater electricity reliability, lower costs, and increased safety.
  - Encourage technological advancement and breakthroughs to overcome the barriers that prevent the achievement of the state's statutory energy goals.

Solar and Wind Forecasting Research Under EPIC

A. Active projects funded through Grant Solicitation PON-13-303 – "*Advancing Utility-Scale Clean Energy Generation*" (EPIC First Triennial Investment Plan)

- Improving Solar & Load Forecasts: Reducing the Operational Uncertainty Behind the Duck Chart (Itron, Inc.; EPC-14-001)
- Solar Forecast Based Optimization of Distributed Energy Resources in the LA Basin and UC San Diego Microgrid (UC San Diego; EPC-14-005)
- High-Fidelity Solar Power Forecasting Systems for the 392 MW Ivanpah Solar Plant and the 250 MW California Valley Solar Ranch (UC San Diego; EPC-14-008)
- Improving Short-Term Wind Power Forecasting Through Measurements and Modeling of the Tehachapi (UC Davis; EPC-14-007)

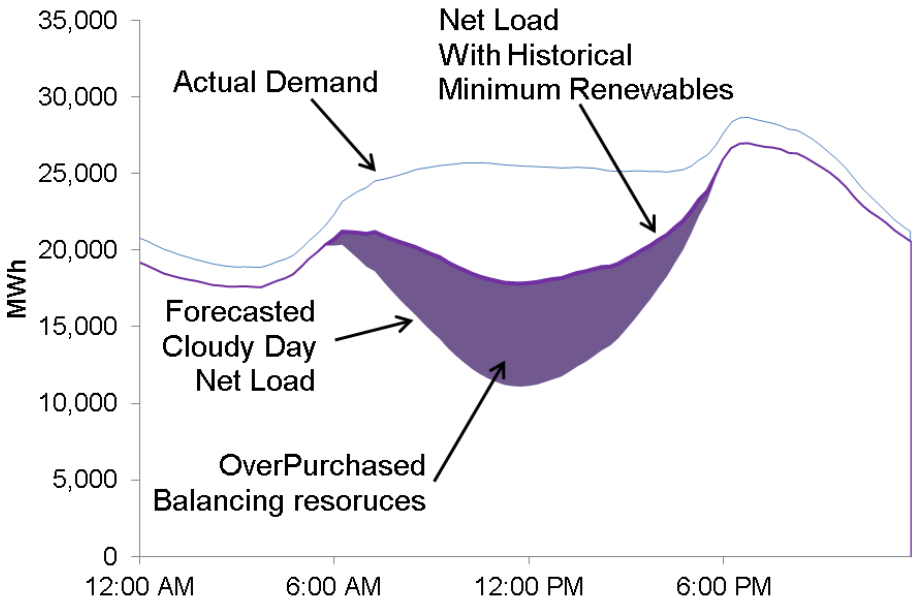
Solar and Wind Forecasting Research Under EPIC

B. Active Grant Solicitation GFO-16-309 – "Solar+: Taking the Next Steps to Enable Solar as a Distribution Asset" (EPIC Second Triennial Investment Plan)

- Funding total of $26 M distributed to 6 project groups
- $1.5 M for Group 5: Holistic Forecasting to Support High-Penetration Solar Grid Operations
- integrated and holistic electricity forecasting approaches for the day-ahead and shorter timescales that consider all grid-connected renewable generation
- Projects goal is to provide tools that the CAISO will integrate into its grid operations and its day-ahead and short-term planning efforts

Improving Solar & Load Forecasts: Reducing the Operational Uncertainty Behind the Duck Chart

- Improve solar forecasts for grid-connected PV in California to create enhanced net-load forecasts, and apply these enhanced forecasts to reduce scheduling errors for utilities and CAISO.



Recipient: Itron, Inc.
Agreement: EPC-14-001

Solar Forecast Based Optimization of Distributed Energy Resources in the LA Basin and UC San Diego Microgrid

- Inform control and scheduling decisions for distributed energy resources with emphasis on energy storage and electric vehicle charging control at warehouse photovoltaic clusters in the LA-Orange-Riverside-San Bernardino-San Diego Counties as well as the UCSD microgrid.

Recipient: UC San Diego
Agreement: EPC-14-005

High-Fidelity Solar Power Forecasting Systems for the 392 MW Ivanpah Solar Plant and the 250 MW California Valley Solar Ranch

- Develop and validate tools capable of monitoring and forecasting DNI and POA irradiance, and the power generation accurately at the Ivanpah Solar Thermal plant, and the California Valley Solar Ranch plant.

Recipient: UC San Diego
Agreement: EPC-14-008

Improving Short-Term Wind Power Forecasting Through Measurements and Modeling of the Tehachapi

- Improve the accuracy of prediction of short-term wind ramps at Tehachapi Pass Wind Resource Area, taking into consideration the area's features, complex terrain and meteorology.

Recipient: UC Davis
Agreement: EPC-14-007

Summary of Forecast Horizon, Models and Error Metrics

Agreement	Forecast Horizon	Forecasting Models	Error Metrics
EPC-14-001 (Itron, Inc.)	Very short (Ramps) Short-term Long-term (Day-head)	Fleetview PowerClerk Metrix IDR	-Mean Absolute Percentage error (MAPE) -Mean absolute error (MAE) - Forecast skill
EPC-14-005 (UCSD)	Very short-term	sky imagery (USI) Smart persistence model	-Root mean square error (RMSE)
EPC-14-008 (UCSD)	Very short (Ramps) Short-term Long-term (Day-head)	Baseline: Smart persistence model Artificial Neural Networks Ordinary Least Squares Support Vector Regression	-MAE -Mean bias error (MBE) -RMSE -Forecast skill
EPC-14-007 (UC Davis)	Very short (Ramps) Short-term	statistical and physics-based forecast models, including BOFS, EBOFS, IOFS, NOOA models	MAE RMSE

Some Notes from Project Results and Activities

- Ways to improve load forecast accuracy of the CAISO's existing load forecast models by incorporating solar forecasts.
- EV charging schedule based on solar production forecast data generated by the sky imager.
- Forecast sensitivity of wind ramping behavior in Tehachapi wind resource area.
- Assessment of the performance of the forecasting models using common error metrics as a function of the forecast horizon.
- Development and installation of low-cost sensors for distributed monitoring.

What are the next steps…

- How are the current forecasting tools being used today and how can we improve the accuracy, reduce the cost, and increase its use and applications?
- What research and development are needed to address anticipated operational needs of utilities and balancing authorities?
- Specific questions on Renewable Energy Forecasting Research Opportunities and Solutions to Support Modern Grid (**Panel 1**)
- Specific questions on Forecasting Gaps, Building a Sensor Network, and Managing Costs (**Panel 2**)

On to Panel Discussions…

Panel 1 :Renewable Energy Forecasting Research Opportunities and Solutions to Support Modern Grid.

Facilitator: Melinda Marquis, National Oceanic and Atmospheric Administration

Panelists:
Case van Dam, UC Davis
Carlos Coimbra, UC San Diego
Frank Monforte, Itron, Inc
Ben Norris, Clean Power Research
John Zack, AWS Truepower
Aidan Tuohy, Electric Power Research Institute
Rob Farber, Independent Consultant

Discussion Panel 1

Question1. Is there a particular forecast horizon relevant for the California energy market that is not addressed by forecasting models you have developed?

Discussion Panel 1

Question 2. What are the biggest challenges in increasing the accuracy of renewable energy and load forecasting at utility and distribution level?

Discussion Panel 1

Question 3. What are the research opportunities to increase the accuracy of forecasts at higher temporal resolution, including at longer time horizons?

Discussion Panel 1

Question 4. Two important factors that contribute to the quality of forecasting are higher-density and high-quality measurements collected from instruments that are rigorously calibrated and well-maintained. Can you share your ideas on research opportunities for these two areas?

Discussion Panel 1

Question 5. Next generation satellite GOES-R will probably lead to more incremental improvements in forecasting throughout California. The improvements of GOES-R are related to the repeat time and the number of bands. This will improve the ability for short-term forecasting especially for fast-developing convective cloud systems in eastern California. Can you mention the specific improvements in your forecasting model with the utilization of GOES-R products? In general, what will be the GOES-R products' role in improving forecast capabilities in California and how will it be integrated in the current forecasting efforts?

Open Q&A, Public Comments

Panel 2: Forecasting Gaps, Building a Sensor Network, and Managing Costs

Staff Coordinator: Angie Gould, California Energy Commission

Facilitator: William Shaw, PNNL-DOE

Panelists: Kevin Clifford, PG&E

Rick Aslin, PG&E

Amber Motley, CAISO

Benjamin Lee, SCE

TJ Vargas, SMUD

Pjoy Chua, LADWP

Scott Winner, Bonneville Power Administration

Clinton MacDonald, Sonoma Technology Inc.

Panel 2 Questions

1. What forecasting tools do you currently use? Are these tools meeting your current needs, and will they meet your anticipated needs?
2. Forecasting has progressed greatly in the last 5 years, and one of the advancements is that probabilistic forecasting has begun to replace deterministic forecasts. Does your organization use or plan to use probabilistic forecasting models? If yes, is there any special application for the decision?
3. How does the increase in distributed energy resources change California's forecasting requirements?
4. What is the current scale of sensor deployment on the transmission and distribution grid? What would be the benefits of increasing the number of sensors, and what types of sensors would be the most beneficial?

Panel 2 Questions (continued…)

5. Will the value of better forecasting and additional sensors offset the cost of these measures?
6. Are there particular forecast horizons for which you would like to see a significant improvement in forecast accuracy?
7. Can you share any additional insights that would be useful in developing the next generation forecast products?
8. What are operational changes that would be helpful to make in concert with improved forecasting to manage uncertainty on the grid?

Open Q&A, Public Comments

Recommendations and Closing Remarks

Please send all questions and comments or suggestions to:

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Deadline to submit questions is January 20, 2017 5:00 PM PDT!